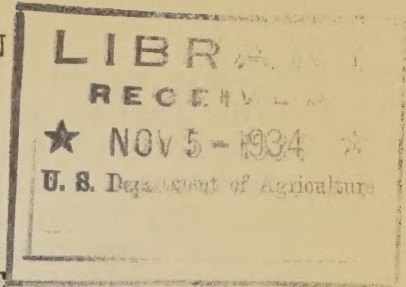


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ANIMAL HUSBANDRY DIVISION
HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII



Under the joint supervision of the

UNIVERSITY OF HAWAII
and the
UNITED STATES DEPARTMENT OF AGRICULTURE

Progress Notes on Experiments and Other Items of Interest

No. 7

October, 1934

These progress notes on experimental work and other items of interest to livestock men in the Territory are issued from time to time by the Animal Husbandry Division. You are invited to suggest other lines of research that you deem important and to submit inquiries to the University.

PINEAPPLE BRAN AS A FEED FOR MULES

By L. A. Henke,
Animal Husbandman, Hawaii Agricultural Experiment Station.

Object

Pineapple bran has been made and fed in the Territory of Hawaii since 1923. Previous to that time the material from which pineapple bran is made--principally the outer shell and sometimes the core of the pineapple fruit--was considered a waste product of the pineapple canning industry.

There have been 79,008 tons of pineapple bran produced in Hawaii to date. Production for the different years is as follows:

<u>Year</u>	<u>Tons</u>	<u>Year</u>	<u>Tons</u>
1923--	1,726	1928--	7,052
1924--	3,563	1929--	7,345
1925--	7,355	1930--	10,916
1926--	6,966	1931--	9,757
1927--	7,043	1932--	7,755
		1933--	9,530

Most of this has been fed to work animals and dairy cattle.

Considerable experimental work has been done regarding the value of pineapple bran as a feed for dairy cattle* and while pineapple

* Henke, L.A. - Pineapple Bran as a feed for livestock. Cir. 2, Hawaii Agricultural Experiment Station (1931).

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PINEAPPLE BRIN AS A FEED FOR MUZZ

By E. A. Henke,
Animal Husbandman, Hawaii Agricultural Experiment Station.

Outline

Pineapple brin has been made and fed in the Territory of Hawaii since 1923. Evidence to that time the material from which pineapple brin is made—principally the outer shell and sometimes the core of the pineapple fruit—was considered a waste product of the pineapple canning industry.

There have been 75,000 tons of pineapple brin produced in Hawaii in 1934. Production for the different years is as follows:

Year	Tons	Year	Tons
1923--	7,343	1927--	7,343
1924--	7,343	1928--	7,343
1925--	7,343	1929--	7,343
1926--	7,343	1930--	7,343
1927--	7,343	1931--	7,343
1928--	7,343	1932--	7,343
1929--	7,343	1933--	7,343

Most of this has been fed to work animals and dairy cattle. Considerable experimental work has been done regarding the value of pineapple brin as a feed for dairy cattle* and white pineapples.

* Henke, E. A. - Pineapple Brin as a Feed for Livestock. Cir. E, Hawaii Agricultural Experiment Station (1931).

bran has been much fed to plantation mules as a part of their concentrate feed, generally with favorable results based on casual observations, exact experimental data on the value of this feed does not seem to be available. The present experiment outlined on these pages was an attempt to get definite experimental data under controlled conditions where all feed fed and refused by each mule was weighed daily and the mules weighed at definite intervals throughout the experiment.

Experiment Made Possible Through the Active Cooperation
of Waialua Agricultural Company, Ltd.

The Hawaii Agricultural Experiment Station does not have enough work animals to carry on research work on the feeding of mules or horses. For the experiment here outlined it was deemed necessary to have at least sixteen mules. Research work in livestock feeding when limited to only a few animals may be quite as much influenced by the individuality of the animals as by the character of the ration fed; to avoid this possibility as large a number as possible is desirable for most reliable results.

The desirability of such an experiment was outlined to Mr. J. H. Midkiff, Manager of Waialua Agricultural Company, Ltd., and his active cooperation was solicited and secured; Joaquin Robello, the stable foreman, was placed in active charge of the experiment for the plantation.

The experiment was planned and allotment of the mules made by the Experiment Station. Monthly reports of all mule weights and weights of feeds fed and refused by each mule were made to the Station and this summary of the experiment is prepared by members of the Station staff. But the mules as well as all feeds were provided by the plantation and the feeding and weighing of the feeds and weighing of the mules and daily recording of these weights were done by plantation employees carrying out the instructions of the Experiment Station. The Station is greatly indebted to Waialua Agricultural Company, Ltd., for their splendid cooperation.

Plan of Experiment

Eighteen mules in a given stable, selected because of its convenient location and satisfactory stall arrangements permitting individual feeding of each mule, not only of the concentrate mixture but of the roughage as well, were divided into two equal lots based on the average of three weights on three consecutive days. This allotment was so made that one mule of each team was put in the "barley"

It has been found that the most reliable method of determining the effect of a treatment on the growth of a group of animals is to compare the results obtained with those obtained in a control group. In the present experiment, the results obtained in the control group were compared with those obtained in the experimental group. The results showed that the treatment had a significant effect on the growth of the animals.

Experiment Made Possible Through the Active Cooperation of Walrus Agricultural Company, Ltd.

The results of the experiment were obtained through the active cooperation of the Walrus Agricultural Company, Ltd. The company provided the animals and the facilities for the experiment. The results showed that the treatment had a significant effect on the growth of the animals. The company's cooperation was essential for the success of the experiment.

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Plan of Experiment

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lot and the other in the "pineapple bran" lot; hence the amount and kind of work done by the mules in each lot was exactly the same. Since the left mule of the team usually carries the rider (if any) in the field, we attempted to neutralize this effect by having the "barley" lot contain four left and three right side mules and similarly the "pineapple bran" lot contained four right and three left side mules. Each lot also contained one water and one dump cart mule. Since these latter mules worked alone, there is the possibility of some difference in the amount of work done by these two "teams."

The experiment was started on March 21, 1934 and the initial mule weights are the average of weights made on March 20, 21, and 22. Similarly the final weights were the average of weights made on August 28, 29 and 30, the experiment ending on August 29, 1934. All weights were made in the afternoon as the mules came back to the stable after a day's work in the cane field.

The Feed Mixtures

Plantation men frequently feed less protein than suggested by the Morrison Feeding Standard for mules at heavy work. Whether such a smaller amount of protein is ample is a matter for separate experimentation, but for the present experiment it seemed desirable that the quantity of protein supplied by the two mixtures should be about the same and in amount, at least, approach the requirements of the Morrison Standard.

The rations which follow are called the "barley" and the "pineapple bran" rations respectively, although the difference between them is largely in the amounts of these respective feeds as both rations contain both feeds.

The costs of the two rations at September 1934 Honolulu prices and the nutrients contained in each are as follows:

			<u>Digestible</u>		<u>Price per ton</u>	<u>Percentage</u>	
			<u>Crude Protein</u>	<u>Total Nutrients</u>		<u>Cost</u>	<u>Composition</u>
			<u>Dry Matter lbs.</u>	<u>lbs.</u>	<u>lbs.</u>		
<u>Barley Ration</u>							
425 lbs. pineapple bran			349	10.2	220.0	\$15	\$ 3.19 28.3
850	"	barley	771	76.5	674.9	42	17.85 56.7
125	"	soybean oil cake meal	112	49.6	105.6	40	2.50 8.3
100	"	linseed oil cake meal	90	31.7	75.9	44	2.20 6.7
1500	"	mixture	1322	168.0	1076.4		\$25.74 100.0
100	"	"	88	11.2	71.8		1.716

			Digestible	Price	Percentage			
			Crude	Total	per	Cost	Composition	
			Protein	Nutrients	ton			
			lbs.	lbs.				
Pineapple Bran Ration								
500 lbs. pineapple bran			658	19.2	416.0	\$15	\$ 6.00	53.3
400	"	barley	363	36.0	317.6	42	8.40	26.7
200	"	soybean oil cake meal	180	79.4	169.0	40	6.50	13.3
100	"	linseed oil cake meal	90	31.7	75.9	44	2.20	6.7
1500	"	mixture	1291	166.3	978.5		\$23.10	100.0
100	"	"	86	11.1	65.2		1.540	

Fourteen pounds of one of these rations respectively were supplied daily to each mule along with 50 pounds of cut (in silage cutter) cane tops over which were poured four pounds of cane molasses. The daily requirements of a 1300 pound mule at heavy work and the nutrients supplied by each ration follow:

Requirements:	Dry Matter lbs.	Digestible		Sept. 1934 Honolulu Cost
		Crude Protein lbs.	Total Nutrients lbs.	

1300 lb. mule at heavy work	26.0	2.14	18.2	
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Supplied by: "Barley" Ration

50 lbs. green cane tops	12.7	.35	8.1	\$.05*
4 " cane molasses	3.0	.04	2.4	.01*
14 " "barley" ration	<u>12.3</u>	<u>1.57</u>	<u>10.1</u>	<u>.240</u>
	28.0	1.96	20.6	\$.300

Supplied by: "Pineapple Bran" Ration

50 lbs. green cane tops	12.7	.35	8.1	\$.05*
4 " cane molasses	3.0	.04	2.4	.01*
14 " "pineapple bran" ration	<u>12.0</u>	<u>1.55</u>	<u>9.1</u>	<u>.215</u>
	27.7	1.94	19.6	\$.275

*Cane tops assumed to be worth \$2.00 and cane molasses \$5.00 per ton.

Nutrient		Dietary		Total		Cost	
lb.		lb.		lb.		lb.	
100	"	100	"	100	"	100	"
200	"	200	"	200	"	200	"
300	"	300	"	300	"	300	"
400	"	400	"	400	"	400	"
500	"	500	"	500	"	500	"
600	"	600	"	600	"	600	"
700	"	700	"	700	"	700	"
800	"	800	"	800	"	800	"
900	"	900	"	900	"	900	"
1000	"	1000	"	1000	"	1000	"
1100	"	1100	"	1100	"	1100	"
1200	"	1200	"	1200	"	1200	"
1300	"	1300	"	1300	"	1300	"
1400	"	1400	"	1400	"	1400	"
1500	"	1500	"	1500	"	1500	"
1600	"	1600	"	1600	"	1600	"
1700	"	1700	"	1700	"	1700	"
1800	"	1800	"	1800	"	1800	"
1900	"	1900	"	1900	"	1900	"
2000	"	2000	"	2000	"	2000	"

Portion counts of one of these ration respectively were supplied daily to each male along with 10 pounds of corn. The daily requirements of a 1800 pound male of heavy work and the nutrients supplied by each ration follow:

Nutrient		Dietary		Total		Cost	
lb.		lb.		lb.		lb.	
100	"	100	"	100	"	100	"
200	"	200	"	200	"	200	"
300	"	300	"	300	"	300	"
400	"	400	"	400	"	400	"
500	"	500	"	500	"	500	"
600	"	600	"	600	"	600	"
700	"	700	"	700	"	700	"
800	"	800	"	800	"	800	"
900	"	900	"	900	"	900	"
1000	"	1000	"	1000	"	1000	"
1100	"	1100	"	1100	"	1100	"
1200	"	1200	"	1200	"	1200	"
1300	"	1300	"	1300	"	1300	"
1400	"	1400	"	1400	"	1400	"
1500	"	1500	"	1500	"	1500	"
1600	"	1600	"	1600	"	1600	"
1700	"	1700	"	1700	"	1700	"
1800	"	1800	"	1800	"	1800	"
1900	"	1900	"	1900	"	1900	"
2000	"	2000	"	2000	"	2000	"

Portion counts of one of these ration respectively were supplied daily to each male along with 10 pounds of corn. The daily requirements of a 1800 pound male of heavy work and the nutrients supplied by each ration follow:

The 50 pounds of cut cane tops, over which were poured 4 pounds of cane molasses, were fed to each mule in a separate stall when the animals came in from work in the afternoon. The largest part of the 14 pound concentrate ration was fed in the evening, the next largest in the morning and the least in the field at noon. Unconsumed cane tops were separately weighed for each mule each morning after the animals had gone to work. All of the concentrate ration was fully consumed every day by every mule but some of the mules did not eat quite all of the cane tops. On the other hand, the stableman reports that some of the mules would undoubtedly have eaten more than the 50 pounds of cane tops if more had been given to them. Each mule is credited with eating the full four pounds of molasses daily. Since this was mixed with the cane tops and only about 95 per cent of the cane tops fed were consumed, it is obvious that a small part of the cane molasses was adhering to the unconsumed cane tops. This amount, however, would be so small that it is disregarded in these figures.

The first part of the paper is devoted to a discussion of the
 various methods which have been proposed for the determination of
 the rate of reaction between a solid and a liquid. It is shown that
 the most reliable method is that of measuring the change in weight
 of the solid as the reaction proceeds. This method is applicable to
 all cases in which the solid is insoluble in the liquid. It is
 also applicable to cases in which the solid is soluble in the liquid,
 provided that the solid is in the form of a powder or of small
 pieces. The method of measuring the change in weight of the solid
 is described in detail, and it is shown that it is possible to
 determine the rate of reaction with an accuracy of 1%.

The second part of the paper is devoted to a discussion of the
 various factors which influence the rate of reaction between a solid
 and a liquid. It is shown that the rate of reaction is influenced
 by the nature of the solid, the nature of the liquid, the temperature
 of the reaction, and the surface area of the solid. The influence
 of each of these factors is discussed in detail, and it is shown
 that the rate of reaction can be increased by increasing the surface
 area of the solid, by increasing the temperature of the reaction,
 and by using a more reactive solid.

Allotment of Mules, Weights, Feeds Consumed

and Feed Costs

Ration and Lot	Mule No.	Position in team	Initial Weight lbs.	Final Weight lbs.	Gain or Loss lbs.	Average daily feed consumption in lbs.			Daily feed cost cents
						Cane tops	Cane molasses	Concen- trates	
Barley Pineapple bran	331 51	left right	1210 1093	1283 1166	✓ 73 ✓ 73	47.0 46.9	4.0 4.0	14.0 14.0	29.7 27.2
Barley Pineapple bran	34 33	left right	1373 1417	1403 1460	✓ 30 ✓ 43	48.4 49.1	4.0 4.0	14.0 14.0	29.9 27.5
Barley Pineapple bran	8 61	left right	1240 1100	1250 1160	✓ 10 ✓ 60	49.7 40.6	4.0 4.0	14.0 14.0	30.0 26.6
Barley Pineapple bran	Dandy 35	left right	1077 1230	1070 1246	- 7 ✓ 16	40.6 44.3	4.0 4.0	14.0 14.0	29.1 27.0
Barley Pineapple bran	78 25	right left	1320 1217	1366 1196	✓ 46 - 21	49.7 45.7	4.0 4.0	14.0 14.0	30.0 27.1
Barley Pineapple bran	53 1	right left	1243 1263	1290 1303	✓ 47 ✓ 40	48.4 50.0	4.0 4.0	14.0 14.0	29.9 27.6
Barley Pineapple bran	3 11	right left	1246 1273	1286 1276	✓ 40 ✓ 3	50.0 49.8	4.0 4.0	14.0 14.0	30.0 27.5
Barley Pineapple bran	14 31	water water	1333 1300	1353 1346	✓ 20 ✓ 46	49.0 49.5	4.0 4.0	14.0 14.0	29.9 27.5
Barley Pineapple bran	102 10	dump cart dump cart	1140 1290	1200 1390	✓ 60 ✓ 100	47.4 48.0	4.0 4.0	14.0 14.0	29.8 27.4
Barley lot Pineapple bran lot		Average Average	1242 1242	1277 1282	✓ 35 ✓ 40	47.8 47.1	4.0 4.0	14.0 14.0	29.8 27.3

一	二	三	四	五	六	七	八	九	十	十一	十二	十三	十四	十五	十六	十七	十八	十九	二十	二十一	二十二	二十三	二十四	二十五	二十六	二十七	二十八	二十九	三十	三十一	三十二	三十三	三十四	三十五	三十六	三十七	三十八	三十九	四十	四十一	四十二	四十三	四十四	四十五	四十六	四十七	四十八	四十九	五十	五十一	五十二	五十三	五十四	五十五	五十六	五十七	五十八	五十九	六十	六十一	六十二	六十三	六十四	六十五	六十六	六十七	六十八	六十九	七十	七十一	七十二	七十三	七十四	七十五	七十六	七十七	七十八	七十九	八十	八十一	八十二	八十三	八十四	八十五	八十六	八十七	八十八	八十九	九十	九十一	九十二	九十三	九十四	九十五	九十六	九十七	九十八	九十九	一百
---	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----

The mules in both lots remained in good condition and all except one mule in each lot made gains showing that both rations supplied ample nutrients. The average "barley" fed mule gained 35 and the average "pineapple bran" fed mule 40 pounds during the 162 day experiment, during which time they were continuously at hard work in the cane fields. It should also be noted that at the end of the experiment the mules were working in the Kawaihoa section and in order to weigh them it was necessary to drive them about 9 miles to the scales. The final weights might even have been higher except for this long walk to the scales at the end of the day's work in the field--a condition that did not exist when the initial weights were taken.

Photographs were taken of each team at the close of the experiment and show their general condition. The following is taken from a report by Joaquin Robello, stable foreman, who watched the mules continuously throughout the experiment:

"Throughout the experiment a close watch was kept over the mules and the following observations should be made part of the record:

General physical condition	Both lots good
Endurance	Both lots good
Condition of bowels	Normal throughout
Sweating	No excessive sweating
Condition of coats	Slick and smooth except for Nos. 25 and 35 (pineapple) and No. 3 (barley).
Stomach disorders	No. 51 had slight attack of colic early in the experi- ment lasting but one day.

Respectfully submitted,

(signed) J. Robello,
Stable foreman."

Summary and Conclusions

1. Eighteen sugar plantation mules were divided into two equal lots, one of which was fed a "barley" ration (56% barley, 28% pineapple bran) and the other a "pineapple bran" ration (53% pineapple bran, 27% barley) for a period of 162 days. The allotment was so made that one mule of each team was fed the "barley" and the other the "pineapple bran" ration.

2. During the 162 days of the experiment, during which time the mules were continuously on heavy plantation work, the "barley" mules averaged 35 and the "pineapple bran" mules 40 pounds gain in live weight.

3. The mules in each lot consumed the same quantity of concentrates and practically the same amount of green cane tops.

4. The average daily feed costs at September 1934 Honolulu prices, assuming cane tops to be worth \$2 and cane molasses \$5 per ton, were 29.8 cents and 27.3 cents for the "barley" fed and "pineapple bran" fed mules respectively, or a saving of 2.5 cents per mule per day resulting from feeding the "pineapple bran" ration. This figure will vary from time to time depending on the relative prices of the various feeds in the rations used but, on the basis of the data supplied by this experiment, it can be readily computed when the feed prices are known.

5. It should be noted that in this experiment pineapple bran was not merely substituted for barley but additional soybean oil cake meal was used in the "pineapple bran" ration so that the protein content of the two rations was practically the same. If this had not been done the "pineapple bran" ration would have been materially cheaper than reported here. Whether such a lower protein content feed would give equally good results is a matter for further experimentation.

